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Systems analysis of an operating system consists of the evaluation of the efficiency, economy, accuracy, and productivity of existing procedures measured against the stated objectives of the library; and the design of new procedures to satisfy the demands of management and user. The data processing subsystem performs ongoing operations of function and decision, which are the elements of system design. A total library system develops methods to utilize three major types of data: bibliographic, fiscal, and inventory. The analys t surveys input and output with worksheet summaries and translates the stated goals of the library into system requirements. Evaluation of current operations precedes design of the new system, which can be planned and tested by flow chart simulation. The final steps to be taken are cost comparisions of the old and new systems, staffing specifications, the writing of reports and manuals, and debugging computer systems, although the end result of systems analysis need not always be an automated system. (TI)

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TUTORIAL ON

E L E M E N T S O F I N F O R M A T I O N S Y S T E M S

Instructor Edition

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ADI Tutorial Manuals

PREFACE

A prime responsibility of a professional society is to foster continuing education activities covering new developments in topics of importance to the work of its members. This is particularly true in rapidly expanding and highly complex technologies such as those in the field of information science.

With this view, the 1967 Conference Planning Committee of the American Documentation Institute (now the American Society for Information Science) chaired by Paul Fasana of the Columbia University Libraries, established a Tutorial Subcommittee to organize training sessions for presentation at the Conference. The Subcommittee, under the direction of Russell Shank, then Associate Professor at the Columbia University School of Library Service, agreed to develop three workshop tutorials for the following areas: elements of information systems; electronic data processing concepts; and generalized programming languages and systems.

The tutorials on these topics ran concurrently. Each began with a general session in which the tutorial leader gave an overview of the topic to be covered. The participants were then formed into smaller workshop or seminar groups for detailed instruction by a team of tutors. Each tutorial lasted the entire day. The general sessions were limited to about 100 people; seminar groups were limited to about 25 people. In the seminar groups each of the tutors either covered the entire topic simultaneously, or presented a part of the information to be covered, repeating their presentations as groups were rotated among them.

In planning the tutorials it was apparent that syllabi or workbooks were needed to assure that the basic information to be presented was uniform and organized for the instructors of each of the groups. It was assumed that if syllabi were carefully prepared they could be made generally available and be useful in similar courses at other national and local meetings of information science groups.

Three manuals, covering the three different topics, were prepared and used experimentally at the Conference. Initially, it was hoped that each manual would contain a comprehensive outline of the topics to be presented, a display of the illustrations and visual material used in the lectures, glossaries, bibliographies, and problems. It was further assumed that the sessions would be more meaningful if an instructor's version and a student's outline (with sufficient space for notes) were prepared. The instructor's edition would have enough detailed information to allow other instructors to present the course.

The variation among the approaches to the three topics treated in the tutorials made it difficult to attain this objective of uniformity in style of presentation, at least on the first attempt. All three manuals have been extensively revised for publication. This material will undoubtedly be improved through refinements as the tutorials are presented elsewhere in the future.

This package contains both an instructor's and a student's version of the syllabus for each topic. Undoubtedly other instructors will wish to make modifications of these manuals to suit local needs and instructor's talents. These manuals are offered, therefore, primarily as examples for

for those who might be planning similar tutorials. The student edition may be produced in quantity locally as required.

Very briefly, the scope of each of the three sessions of the 1967 tutorials was as follows:

Tutorial I. Elements of Information Systems.
Paul L. St. Pierre, Principal Tutor

An introductory course for those with no previous experience or formal training in systems analysis. Objective will be to familiarize participants with the techniques (file analysis, record analysis, flow-charting, costing) and the terminology of systems analysis. Those who complete this tutorial should have a knowledge of what systems analysis is, what function it serves and how it can be applied.

Tutorial II. Electronic Data Processing Concepts.
Bruce Stewart, Principal Tutor

For those with little or no experience with EDP equipment. Emphasis will be on a functional description of various types of equipment. Participants will be given an understanding of how such equipment works. They will not be trained to operate particular machines.

Tutorial III. Generalized Programming Languages and Systems.
Thomas K. Burgess, Principal Tutor

For those with considerable systems analysis and programming experience. Presentation of a comparative analysis and review of the various programming languages currently available, especially as they apply to information storage and retrieval. The relative merits of different program languages for use in textual analysis, file structure, file manipulation, and similar topics will be stressed. Program languages to be covered include FORTRAN, COBOL, PL 1, SNOBOL, and ALGOL.

Russell Shank
Washington, D.C.
July, 1968

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I. INTRODUCTION

Systems analysis is prerequisite to a well-designed and successfully automated system, but the end result of systems analysis need not be an automated system. Study methods and techniques can and should be used in analyzing, evaluating, and designing any system of procedures. The librarian familiar with the concepts and techniques of systems analysis can increase the efficiency and productivity of the library even if available mechanized equipment is only the typewriter.

Systems Analysis: A Definition

Systems analysis is the logical analysis of a present operating system; the evaluation of the efficiency, economy, accuracy, productivity, and timeliness of existing procedures measured against the stated objectives of the library; and, the design of new methods and procedures to more effectively satisfy the demands placed upon the library by management and the user.

Analysis and design are distinct phases. Analysis is a rigorously controlled inquiry into existing conditions; design, by contrast, is a synthesizing process in which new ideas are generated and defined. Design is the final phase of systems analysis involving creative thinking, coordination of the conclusions reached in the analysis, and deductive reasoning directed toward realization of the stated objectives of management.

The Need for Systems Analysis

As business organizations, libraries are complex organizations of interacting operations whose control cannot be left to intuition if the total system is to achieve its stated objectives. The following recent developments have made the need for Systems Analysis in libraries critical:

1. An increase in the quantity and sophistication of demands on the library.

2. Continuing shortage of qualified librarians.

3. Substantial increase in printed data.

A system can be judged by the following criteria to assess whether it is fulfilling its goals satisfactorily:

1. Increasing cost for processing a unit of material.

2. Increasing backlog of unprocessed materials.

3. Deteriorating services to the library's users.

If a preliminary evaluation reveals any or all of these problems, library management must decide whether a major systems study is required or only minor changes need to be made.

Planning for Systems Analysis

Management Responsibility

Systems study represents a major effort resulting usually in major changes; therefore, the entire library staff, backed by strong management support, must be involved in planning and conducting the study.

The guidance, direction, and personal participation of the Library director are critical in planning and conducting the study.

Staffing

The first responsibility of the director is the selection of staff to plan and conduct the study. Ideally a library officer having appropriate responsibility and authority should head up the effort and be assigned an adequate staff to assist him. This should include:

1. At least one fully trained and experienced in the application of management-analysis techniques.

2. At least one skilled in EDP methods if an automated system is contemplated.

After appropriate orientation, the study staff together with the

library director should prepare a detailed plan for conducting the study.

Preparing the Study Plan

1. Define the Problems. The study staff should identify and describe the specific problem (or problems) to be studied. Problem definition should be in sufficient detail to serve as a guide to the staff members and to inform the other members of the library's organization who will be involved in, or concerned with the activities to be studied.

2. Define the Goals. The study staff must obtain from the director the goals that the system must satisfy and the relative importance of the stated goals. This is critical in systems study planning. The stated goals should be validated through discussion with library users, department heads in the library, department heads of the parent organization of the library, and with key administrative officers of the library's governing organization. The goals of a system determine the requirements of a data processing system. Goals are basic in evaluating the current system and in designing a new system. If goals are not precisely stated, correctly defined, and under-

stood in detail, the results will be inaccurate evaluation of current operations and faulty design of a new system.

3. Define the Scope. A precise definition of scope identifies the particular procedures to be studied, the organizational units in which the operations are performed, and the activities involved.

4. Determine the Analytical Techniques to be Used. In order to insure that a study is logical, and systematic, and that the results are consistent and comparable, the study staff should determine and specify the analytical techniques to be used. This manual attempts to provide knowledge of the methods, techniques, and tools which are useful.

5. Establish a Time Schedule. The final step in the planning stage is the establishment of a time schedule. The study staff should establish for individual study-assignments, and for the effort as a whole, a list of specific, identifiable phases with target dates for the completion of each.

Evaluating the Study Plan

The director should review the plan both with the study staff and

with other members of the library's administration. When the plan has been approved, the director should formally announce the initiation of the systems study to the entire library staff. The announcement should:

1. Indicate the reasons for the study.
2. State the objectives of the study.
3. Describe the benefits expected from the study.
4. Solicit the full cooperation of the members of the staff, stressing that a successful study can only be realized with their full support and interest.

Phases of a Systems Study

A systems study consists of three phases, each of which consists of a series of defined steps to be completed in their assigned order if the study is to result in an optimum system; they are:

1. ANALYSIS of the current procedures.
2. EVALUATION of current methods and procedures in terms of the library's goals.
3. DESIGN of improved systems.

The following sections summarize the steps taken in each phase of the systems study.

The Analysis Phase. In this phase the "analyst" or "analysts" acquires a complete understanding of all aspects of the system. This includes determining the interrelationship between the system under investigation and all other systems which place demands upon it. This is accomplished by:

1. Surveying Requirements. The requirements of the system are the DEMANDS placed upon the system from all sources. The analyst determines in light of the stated goals the demands, where they originate, and how they are satisfied by the present system.

2. Surveying Current Operating Conditions. The analyst obtains a working knowledge of the operations required by the system, the sequence in which they are performed, the functions, decisions and actions required for the performance of each operation, and the inputs and outputs of each operation. A survey of equipment is done. A detailed survey of individual procedures is done to assess whether job descriptions match the functions being performed.

3. The Surveying Outputs. The outputs (or products) of a system consist of the reports, records, actions

that are prepared or performed to satisfy the requirements or goals of a particular system. The analyst determines why, how, when, and by whom the output is prepared, what information it contains, and what actions are required to prepare this output.

4. Surveying Inputs. Inputs to a system include the raw data that the system must manipulate in order to generate the outputs needed to satisfy a system's requirement. The analyst determines what inputs are received, how many, how often, where they originate, what informational elements are contained and what functions, decisions, and actions are required to convert input data into the desired output.

The Evaluation Phase. The evaluation of a system involves determining how well present methods and procedures satisfy stated goals. This is done by analyzing the data gathered in the analysis phase. The staff must organize this data and proceed to evaluate each operation within the system to determine how effective, efficient, timely, accurate and at what cost the present system fulfills its requirements.

Upon completion of the evaluation, the study staff should prepare a

report of findings and recommendations, and submit this report to management for consideration. Recommendations may be to maintain present procedures, to modify or redesign present procedures, or to design a completely new system. In addition, recommendations will state whether to adopt a manual, semiautomated, or automated system.

Management must have enough detail to make decisions consistent with the overall organizational goals. Depending upon the study recommendations and the management decisions, the staff may or may not proceed to the final phase, that of designing a new system.

The Design Phase. After authorization to proceed has been granted, the study staff proceeds to design the new methods and procedures recommendes in the study report. In designing a new system, the study staff's responsibilities are to rearrange the flow of data and material through the system; to establish new methods and procedures to perform necessary operations; to organize each function, decision, and action into its proper place in the system.

II. DATA PROCESSING SYSTEM

Definition

A data processing system is defined as the organization and methods used to effect changes in the form and/or content of data in order to satisfy the demands placed upon the system. The main functions of a data processing system are to manipulate, store, and retrieve information. It accepts data as input, performs predetermined operations on this data, changing its content and/or the form, and produces desired results. Data processing systems are ONGOING AND DYNAMIC processes consisting of interrelated operations which become increasingly complex as input and output requirements increase.

Data Processing Subsystem: A Definition

Complexity in a data processing system prohibits analysis, evaluation, and design as a unit. The objective of the analysis phase is to identify the major activities of the system, which are called subsystems. A subsystem consists of a related group of operations which satisfy one or more secondary requirements of the system, contributing to the satisfaction of the system's primary requirements. Having identified major subsystems the operations performed in the subsystem are isolated, and the functions and decisions, associated

with the processing of each input to prepare desired output, are defined. Finally, the actions resulting from the various decision must also be defined.

The functions and decisions are the basic elements of a data processing system. The evaluation of a system consists of determining how well the functions are organized and performed, and how appropriate the decisions are in satisfying the requirements of the system. The design of a new system must start with these basic "building blocks", i.e., the elements.

Data Processing Subsystem - Example

Figure 1 illustrates the idea of a library system. Shown schematically is the combination of all the elements required to make the acquisitions system operational. The acquisitions system illustrated consists of the following subsystems: preorder search; ordering; receiving and checking; and accounting and reporting. As indicated, the subsystems are interrelated. For example, the ordering subsystem taken as a unit, could not be meaningfully applied alone, for it requires verified data supplied by the preorder search subsystem.

Data Processing Subsystem - Operations Analysis

Each subsystem consists of a group of interrelated operations, with each operation requiring that certain functions and/or certain decisions be performed.

Two operations in an accounting and reporting subsystem are analyzed:

(Note to Instructor: The following matrix is reproduced in the student manual, without the indicators in the left-hand columns. Have the students fill in the check marks as you proceed with an oral runthrough of the analysis.)

Operation	Function	Decision	Action	
				Clear invoice for payment
				Is invoice correct and complete
				Yes: clear invoice
				No: determine invalid data; correct or return invoice
				Assign proper account number to invoice
				Post the order, invoice and account numbers and amount to invoice register
				Maintain current balance on each book fund
				Post invoice amount to proper book fund
				Calculate new balance for each book fund
				Has book fund reached minimum balance (balance equal to or less than $100.00)
				Yes: notify library director for authorization of additional funds or discontinue ordering

The level of detail in such an analysis as illustrated above depends upon the type of system being developed. If a computer system is contemplated, the functions and decisions must be defined in sufficient detail to permit the "programmer" to program a system.

Total System Concept: A Definition

Figure 2 illustrates the total library system concept. The total system operates within an environment dictated by the goals of its parent organization or governing body.

The simplest way of defining the total systems concept is by stating its objectives. They are:

> To organize administrative work flows from the viewpoint of the library as a whole without regard for barriers of organizational segments.
>
> To develop data processing systems whereby source data are recorded once and thereafter perpetuated in various summary forms to meet departmental operating and financial needs without repetitive processing.

Although these two aims can be accomplished to a limited degree by manual methods, it is in the complexity of the interaction among systems which is causing libraries to investigate the concept of "total systems" using computer techniques.

The realization of a total system can only occur after the major operating subsystems have been designed and integrated allowing the interaction and exchange of information in a logical and systematic manner. The planning of individual systems is not an end in itself, but must be in the context of developing a total system.

A total library system involves developing methods to prepare, control, and utilize three major types of data: bibliographic, fiscal, and inventory.

This requires designing integrated procedures for major library subsystems: administration and planning; acquisitions; cataloging; serials control; circulation; and reference.

III. DETERMINING THE REQUIREMENTS OF A LIBRARY

Library Objectives

The study staff translates the stated goals of the library into the requirements imposed upon the system, and identifies other requirements and their sources:

1. Outside of the local organization: ALA rules for filing; rules for main entry; reports required by governmental agencies and professional groups.

2. Outside of the library locally: accounting information required by Central Purchasing; user requests for information and services.

3. Within the library itself: other systems depending upon this system for information; the director of libraries requiring certain reports and statistics.

4. Within the system itself: information required by a subsystem from another; information required within a subsystem.

Developing Systems Requirements

The study staff should interview the following people to identify the requirements each one places upon the system:

1. The director of libraries.

2. The users of the library.

3. The heads of departments within the parent organization affecting library operations; such as purchasing, accounting, etc.

4. The head of each major operating system within the library.

5. The head of the system being surveyed.

6. The personnel within the system being surveyed.

Worksheets for Interviews (Refer to Figure 3)

Figure 3, Worksheet for the Survey of Requirements, can be used during interviews to determine the requirements placed upon the system by each interviewee.

1. What bibliographic, statistical and account records or reports are needed?

2. What system(s) generates the requested records or reports?

3. What information these reports and records must contain?

gure 3

WORKSHEET
For the Survey of Requirements

Prepare a copy of this worksheet for each of your requirements. 2. Attach a completed sample of each record or report.

System	Analyst	Date
ame of Person Interviewed	Position	
Name of Supervisor	Position	

Describe the Requirement:

Describe decisions you make in satisfying this requirement:

Describe what action you may take as a result of your decisions:

Describe the functions you perform in satisfying this requirement:

Describe how you use each bibliographical, fiscal, inventory and statistical record or report satisfying this requirement (use additional forms as necessary). PLEASE ATTACH A COMPLETED SAMPLE OF EACH RECORD OR REPORT; on samples circle in black information you use, in red information you add, and, in blue any information regarded unnecessary.

4. Why and how this information is used?

5. Is the information received in useable or final form; if not, what functions must be performed to adapt it for use?

6. Is the proper information furnished for making necessary decisions; and what are these decisions and their bases?

7. What actions are normally taken as the result of these decisions?

IV. ANALYZING CURRENT PROCEDURES

Functions in the Preliminary Survey (Refer to Figure 4, Sample Worksheet for the Preliminary Survey.) (Note to instructor: be prepared to describe some examples of typical entries that might be entered on the worksheet as the surveys are conducted.)

1. Equipment Survey

   a. Equipment used in present system.

   b. Other equipment available in the library and outside of the library.

   c. Location of each item of equipment.

   d. Special features of any items of equipment, such as tape typewriter with punched card input and output.

   e. Percentage use of each item of equipment.

   f. Authorization and procedure required for use of equipment outside of the library, and its availability schedule.

   g. Age and condition of each item of equipment.

2. Personnel Survey gathered from organizational charts, job descriptions and personnel classification schedules.

   a. Positions currently authorized in the system.

   b. Job levels - classification and grade of each authorized position.

   c. Special skills required in each position.

   Gathered from job descriptions and personal interviews:

   a. Name of incumbent for each authorized position, noting vacancies, or additional personnel not reflected in organizational chart.

   b. Actual job level of each incumbent.

   c. Special skills currently available.

   d. Job descriptions accurate or out-dated; if out-dated, modify or conduct job-analysis as required.

Identification of Subsystems and their Elements - General

As stated in Section II, Data Processing System, one of the initial responsibilities of the study staff is to identify the major sub-

systems, and in each subsystem identification of all elements (functions, decisions and actions) making up the operations of each subsystem. The analyst can accomplish this most readily by becoming involved in the actual day-to-day operations of the system. In conjunction with the survey of inputs and outputs, the analyst observes and interviews each person in the system, recording the elements for which each is responsible. In his study of the system, the analyst must provide sufficient detail to allow flow charting and analyzing the present system to be done which the study staff will use during the evaluation phase.

Organizing Survey Findings

The verso of the Preliminary Survey Worksheet (Figure 4) may be used by the analyst to organize his findings:

1. Indicate in the appropriate box, by a check mark, the type of component.

2. Supply the name of the component if so identifiable.

3. Supply the description of each component.

   a. Subsystem: indicate major requirements. Identify the other subsystems and/or system with which it interacts.

b. Operations: identify by name, the inputs and outputs of each operation together with the number of items received and the number processed, by day, or by week, or by month.

c. Functions: describe procedures and methods for performing each function.

d. Decisions - Actions: describe criteria for each decision and the resulting action taken.

4. Standard rate: This is defined as the number of work-units processed per unit of time. This should be determined for each function if practical; if not, the standard rate for each operation must be calculated.

V. DETERMINING OUTPUTS

General Comments

Outputs of a system consist of records and reports prepared or maintained by the system. During the survey of requirements, each output is identified. Outputs may be categorized by type: bibliographic, fiscal and inventory.

Functions of the Analyst in the Survey of Outputs (Refer to Figure 5, Worksheet for the Survey of Outputs.)

(Note to the Instructor: Work through the form with the class supplying illustrative examples as necessary.)

1. Identify the requirement(s) which the output satisfies in whole or in part.

2. Identify the type of output: bibliographic, fiscal or inventory.

3. Define the specific information contained in each output, and the source of such information.

4. Determine for each report prepared by the system:

   a. Who receives the report

Figure 5

WORKSHEET
For the Survey of Outputs

1. Prepare a worksheet for each output that is prepared or maintained.
2. Attach a completed copy of each.

SYSTEM	ANALYST	DATE
NAME OF PERSON INTERVIEWED	POSITION	
NAME OF SUPERVISOR	POSITION	
NAME OF OUTPUT		
TYPE OF OUTPUT: Bibliographic, Fiscal, Inventory, Statistical, Record, Report		

Identify the requirement(s) which use the output:

Describe the functions you perform in preparing or maintaining this output:

Describe the decisions:

Describe the action taken:

RECORDS		
Present size of file:	How many records added to the file:	Daily ____ Weekly ____ Monthly
Type of file:	How file arranged:	
Are written rules available: Yes No	How long is record kept in active file:	How long kept in inactive file:
How often is file referred to:	By whom:	
How much time required to prepare record:	How much time spent on filing:	
How much time spent in updating:		

REPORTS	
How many copies:	What use is made of each copy and by whom:
How much time spent in preparing report:	

What information, if any, is added to the output and where does the added information originate. Circle this information in red on sample:

Is any of the information in this output transcribed to other forms or records. Circle this information in blue on sample:

Does the information contained in the output appear on other records independently originated in the system. Circle this information in black on the sample:

Use this area for your comments; please do not forget to attach a completed form:

This area for the analyst's comments:

b. Number of copies needed.

c. Report, intermediate or final.

d. Method of preparation.

5. Determine for each record maintained by the system:

a. How long is the record kept in active files; inactive files.

b. Frequency of reference to a given record, and by whom.

c. What information is used from the record, and how used.

d. Is information available in any other record of the system.

e. Is information added to this record continuously; if so, by whom and how often.

f. What is the disposition of the record if not permanent: destroyed, transferred to another system.

6. How many outputs are prepared or maintained, and how much time is spent in this activity.

7. At what point in the system does the output originate.

8. Is information needed from other systems to complete the output, and, if so, from what systems and what information.

9. What functions of the system are involved in generating the output.

10. What decisions are required in preparing the output.

11. What actions result from these decisions and the effect of such actions upon the outputs.

A sample of each output should be collected from the person responsible for preparing it, together with answers to the following questions:

1. What data, if any, is added to the output and where does the added data originate.

2. Is any of the data in this output transferred to other forms or records.

3. Does the data contained in the output appear on other records independently originated in the system.

Summarizing the Requirements (Refer to Figure 6)

(Note to Instructor: After completing the survey of outputs, fill in the Summary Worksheet for the Survey of Requirements (Figure 6)

Figure 6

SUMMARY WORKSHEET FOR THE SURVEY OF REQUIREMENTS

SYSTEM	ANALYST	DATE

Name or description of requirement	Identify each output which is required to satisfy the requirement (report, records)	What operations prepare or maintain each of these outputs					What activities receive each of these outputs both within or outside the system				

RENSSELAER LIBRARIES
TROY, NEW YORK

VI. DETERMINING THE INPUTS TO A SYSTEM

General Comments

Inputs to a system comprise the body of data upon which the system acts in order to satisfy its requirements. Each subsystem within a system is on a standby basis until it is "triggered" into action by the entry of one or more inputs. Each input may require the performance of one or more functions and/or the exercise of required decisions which lead to predetermined actions.

Characteristics and Sources of Inputs

Before the functions of the analyst are discussed, it is necessary to describe some of the characteristics and sources of inputs.

1. Types of input

   a. Primary input - One which activates a subsystem. This type of input usually involves major clerical, professional, or, mechanical functions, decisions and actions. In acquisitions, for example, a book purchase request triggers the pre-order search subsystem. The receipt of a book activates the receiving and checking subsystem.

   b. Functional input - One which usually involves only

minor clerical functions requiring no decisions. For example, notice of delayed publication requires that a clerk post the new date of anticipated receipt to the open order records.

c. Instructional input - One which modifies or explains a primary input. For example, in cataloging, the cataloger creates a worksheet which gives instruction to a clerk in processing nonroutine items.

d. Informational input - One which potentially may become the basis for one of the types of inputs preceding. Book blurb: discard, or, use (Primary input). New filing code: adapt to local situation, or, disregard (Instructional input).

2. Sources of input

As in the case of requirements, inputs to a system are received from many sources and, in some cases, the form and content of the input cannot be altered or controlled.

Categories of sources of inputs are:

a. From outside of the local organization.

b. From outside of the library locally.

c. From within the library itself.

d. From within the system itself.

3. Forms of input

   a. Manual input (handwritten, typed)

   b. Machine record (punched card, paper tape, magnetic tape)

   c. Verbal communications

Functions of the Analyst in the Survey of Inputs (Refer to Figure 7, Worksheet for the Survey of Inputs.)

(Note to Instructor: Work through the form with the students having practical examples ready.)

In this phase of the analyst's survey, the flow of each input is followed through the system. Ansers to the following questions for each input should be recorded:

1. What is the form of the input? Is it necessary that the form be changed for use within the system?

2. Where and how does the input originate?

3. At what point does the input enter the system; at what point is it used?

4. What data from the input record is used at each such point?

5. Is data added to the input record for use at other points; or, is a new input record created?

6. What functions, decisions, and actions are triggered by the input?

7. Is the input eventually an output of the system?

8. What is the final disposition of the input?

9. What files and records does the input affect?

10. Are there written procedures that describe the functions of the input?

11. What is the type of the input?

Primary and functional inputs must be identified. Instructional and informational inputs must be analyzed. Instructional inputs should be reduced to as few as possible by establishing standard procedures covering all possible nonroutine functions.

For informational inputs, the analyst identifies the decisions and actions occurring both within and outside the system, requiring the entry of the informational input into the system; he must identify the highest level at which these decisions and actions occur; and finally, he must decide which of the other types of input (primary, functional, and instructional) the informational input will become accepted.

Figure 7

WORKSHEET
For The Survey of Inputs

Prepare a copy of this worksheet for each input received. An input is any item of information upon which, or, as the result of, you perform any or all of your assigned functions.

Attach completed sample of the input.

STEM	NAME OF INPUT
	ANALYST / DATE
ME OF PERSON INTERVIEWED	POSITION
ME OF SUPERVISOR	POSITION

view the description of the types of inputs given below and check the one which best describes this input:

☐ PRIMARY INPUT: involves major clerical, professional or mechanical functions, decisions, and actions.

☐ INSTRUCTIONAL INPUT: modifies or explains a primary or functional input.

☐ FUNCTIONAL INPUT: involves only minor clerical functions requiring no decisions.

☐ INFORMATIONAL INPUT: potentially may become the basis for one of the other types of inputs. Please answer additional questions below on informational inputs.

informational input, who makes the
cision that it is to enter the system:

you make the decision, on what is
based:

Which of the other types of input does it become:

ource of
put:

Do you have authority over this source: ☐YES ☐NO

rm of
k: ☐Handwritten ☐Typed ☐Punched cards ☐Paper tape ☐Verbal input ☐Other (describe)

input used in its
riginal form: ☐YES ☐NO

Does the input enter the system at your operation: ☐YES ☐NO

scribe decisions you make in processing
is input:

scribe what action you may take as a re-
lt of your decisions:

scribe the functions you perform in pro-
ssing this input:

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w many do you receive: ____Daily ____Weekly ____Monthly	How many do you process: ____Daily ____Weekly ____Monthly
w much time do you require process this input:	What is the disposition of this input: Destroy Forward File
used by other functions, which do you send it:	If verbal input, do you record for later use by you or others: YES NO
you do record verbal input, what form:	What is the name of the form:
ow long is this input kept n active files:	How long kept in inactive files: / How often is this file referred to: ____Active ____Inactive
How many of these forms are filed: ____Daily ____Weekly ____Monthly	Are written procedures available for the processing and control: YES NO

hat information do you add to this input -- where does it come from; if other form, name it.
ircle this information in red on sample:

o you copy any information from this form on to other forms or records; if so why.
ircle this information in green on sample:

s any of the information on this form unnecessary for your operation.
ircle this information in blue on sample:

oes any of the information on this form appear on other forms used in this system other than those mentioned above.
ircle this information in black:

Use this area for your comments: Please do not forget to attach a completed form:

This area for the analyst's comments:

Summarizing the Results (Refer to Figure 8)

The analyst, upon completion of the survey of inputs should systematically summarize the foregoing data for each input on a summary worksheet. (For an example, see Figure 8.) What information on each input is necessary, and at what level of the system is it used? The analyst must be aware that one input document may affect multiple operations, and that it might serve as input to more than one level of the operation, or to more than one subsystem in the system. He must determine, at each level, what information in the input is required. Further, he must determine what the minimum amount of information is that will allow for the completion of the system at each level. For example, on a purchase form, it is necessary to have the complete author's name at the time we order the book. It is not necessary at the time of searching because the purpose of searching is to verify the author's name.

The analyst must determine the disposition of an input document, when it has served its purpose: is it retained; is it filed (by main entry, by call number, by title); if it is filed, what function does it serve? Too often files are retained which serve little or no purpose.

Figure 8

SUMMARY WORKSHEET FOR THE SURVEY OF INPUTS

SYSTEM				ANALYST									DATE				
Name or Description of Input	Type of Input	Form of Input	Deposition of Input	Number Processed D, W, M	Originating Source	Input Point of Entry to System	What Operations Receive this Input						What Operations Require this Input				

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He must determine whether the original form of input is used at various levels in the system or is it rewritten. If it is rewritten, why is it rewritten; why can't the input be used in its original form; if it cannot be used in its original form, can the form be changed; and if changed, what is the effect at the originating source?

The analyst must determine, in the case of <u>verbal</u> communications within the system, is this the most effective form of input from one level to another, or, within the same level. Is the data that is transmitted through the verbal communications something that is required later in the system, and therefore must be retransmitted by someone else? Is the information that is transmitted of importance to the system? Is the information that is transmitted an output of the system that is being passed up the line to eventually be incorporated in a report? If so, why is it not recorded on the report at the point where it originates instead of up the line where the chances of error creep in.

Are verbal inputs to the system allowed from <u>outside</u> the organization? A fundamental rule in any system is to never accept verbal input from outside the system.

Having all the information available on the system, the analyst is prepared to proceed with the <u>evaluation</u> of the system, phase 2 of the systems study.

VII. EVALUATION OF THE CURRENT OPERATING SYSTEM

The second phase of the systems study is the evaluation of current methods and procedures, upon which the analyst bases his report of findings and recommendations.

Areas of Evaluation - Adequacy of System Elements

The analyst determines:

1. That the necessity of present requirements are those which, in fact, are necessary for the successful operation and management of the system and the total system.

2. That the current methods and procedures are adequate for processing the current as well as the anticipated work loads.

3. That the outputs and controls of the system adequately fulfill their requirements within the total system.

4. That the inputs to the system provide sufficient data, in proper form, so that they fulfill the requirements under current operating methods.

5. Is staffing sufficient in relation to present methods?

6. Does the equipment available allow application of efficient methods?

Other Areas of Analysis

1. Compute the cost of processing a unit of material through the system.

2. Measure the productivity of the system.

3. Determine whether the system provides data promptly for timely action.

4. Evaluate the accuracy of data supplied.

Preparing the Written Report

Finally, the study staff must submit to management a written report stating precisely its recommendations, i.e., design of a new system, modification of the present system or continuation of the present system without change. Depending upon management's decisions the study staff may or may not proceed to the final step of a systems study: that of design.

Stating Conclusions

The analyst has available the following documentation gathered in the planning and analysis phases of the survey:

1. Managerial statement of goals.

2. Current operating procedural manuals, if available.

3. The worksheet prepared on each requirement. (Figure 3)

4. Preliminary survey worksheet. (Figure 4)

5. Worksheet prepared for each output. (Figure 5)

6. Summary worksheet prepared for all requirements and associated outputs. (Figure 6)

7. The worksheet prepared for each input. (Figure 7)

8. The summary worksheet summarizing all inputs. (Figure 8)

The worksheets contain all the data the analust needs for the analysis and evaluation of current procedures. It remains for the analyst, prior to evaluation, to systematically summarize this mass of data. To do this, he uses the technique of flow charting. (Examples of flow charts are appended at the end of this manual.)

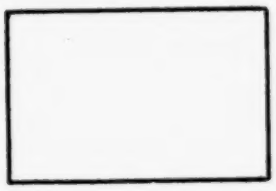
Flow Charting - A Definition

Flow charting is the shorthand of the systems analyst, providing a set of standard symbols which can be used to represent the elements (Functions,

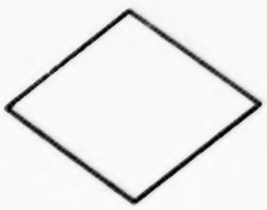
decisions and actions), the inputs, and the outputs. The flow chart illustrates, graphically, the flow of work or data through a system and the sequence in which action is done. A system is a dynamic process which is continuously changing. The flow chart stops action within a system; allowing the analyst to study the old system, or design a new system.

Flow Charting - Symbols

The following symbols are those most often used in flow charting.

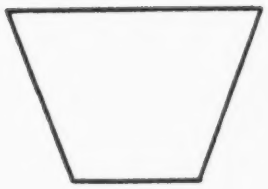


Processing or Instruction represents a clerical or mechanical function such as: search catalog, type order, etc.



Decision represents a point in a system where a decision must be made as to what action is to be taken based upon variable conditions.

Flow of Work indicates the direction of the flow.



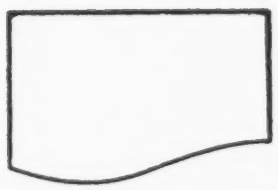
Input - Output represents any form or type of input or output media.

Connector indicates the entry point or exit point from one component to another.

The following symbols may be used when more detail is desired.

Punched Cards

Punched Paper Tape

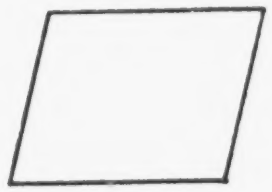


Document

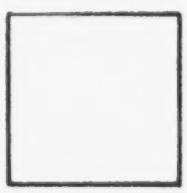
Magnetic Tape

Random Access, Disc, Drum

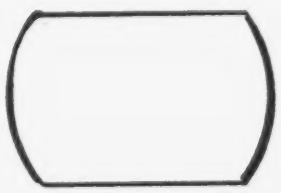
Processing Functions:



Clerical Operation a manual offline operation not requiring mechanical aid.



Mechanical Operation a machine operation supplementing the main processing function.



Keying Operation any operation utilizing a key-driven device, such as a card punch.

Flow Charting - Rules

The following general rules should be used in flow charting:

1. Conventional symbols should be used so that others may be able to follow them.

2. The system and/or its components should have a clearly defined beginning and ending in the chart.

3. The flow of work should always be in one direction, normally top to bottom, left to right.

4. No directional flow-line should be unconnected at any point.

5. The description in the symbols should be understandable to others, using terminology applicable to the system being charted.

6. Additional side notes should be used to provide a thorough understanding.

Uses of a Flowchart

During evaluation, the analyst reviews the results he received in the first three parts of the survey. To test his findings and con-

clusions, the analyst uses the flow chart as a simulator of the system. By following the flow through its associated functions, decisions and actions, he verifies or disproves what results are obtained under any and all possible operating conditions. This process is described in the following:

Simulating Workloads

1. Both the component as well as the overall system should be tested under various workloads to determine the maximum capacity of the system. Does the workload and accompanying cost meet the standards of management's goals? In an acquisitions system, for example, three factors affect the workload: the number of requests received, number of orders processed and the number of books received. The size of workloads throughout the system depends upon the volume of book purchase requests. By varying the number of requests, the ability of the subsystems (pre-order searching, ordering, receiving, accounting and reporting) is tested and their maximum capacities estimated.

Gathering Statistics

2. Do the current requirements of the system burden the manager of libraries or intermediate managers with

statistical or other informational detail. Does management need all such reports or can the modern principle of "management by exception" be applied for seeing that management gets only the information required at respective levels.

Management by Exception

3. Management by exception is a principle whereby management receives only that information upon which action is indicated. For application of this principle, it is necessary that management be able to define the information required for taking action, and to define the point at which such action may be taken. Management by exception is not confined to the top level of administration. For example, in the serials system, the serials librarian in controlling the claiming of serial issues, does not need to receive a report of all serial titles received in a given period in order to find out what issues have not been received; rather he should have a report on those issues which should be claimed.

Evaluation of Outputs

4. Each output (reports) must be tested for adequacy in

meeting internal and external requirements. Do the outputs of the pre-order search subsystem, for example, furnish sufficient bibliographic data to satisfy the requirements of the ordering subsystem? If a "total system" is one of management's goals, will the present outputs of the pre-order search subsystem furnish the necessary bibliographic data required by the cataloging system, and, in both cases is the data furnished in useable form. If not, what modifications can be made in the pre-order search subsystem; what effect would such modifications have upon efficiency, capacity and cost of the pre-order search subsystem's operations; what effect would such modifications have upon the number and kind of staff needed in the pre-order search subsystem, viz, additional clerical, additional professional workers, etc., etc.?

VIII. SYSTEMS DESIGN

General Comments

A systems study does not necessarily result in an automated system. Therefore, the study staff should be conversant not only with the techniques of automation but also with techniques of manual procedures and the various types of supporting business machines (punched card systems, accounting, copying, duplicating, etc. machines).

Even in the most sophisticated of computer-based systems, there is a substantial use of manual procedures to gather information, to prepare inputs for the computer; and to produce the outputs of the system.

System Requirements

The following points should be considered:

1. Analyze requirements in terms of a computer system, keeping in mind that the computer system can be assigned many of management's routine decisions.

2. Analyze for all possible applications of the "management by exception" principle, in order to provide

management only the data upon which action may be required.

3. Determine and design reporting systems that best serve management's needs.

Characteristics of Computer System

Most libraries cannot justify the cost of maintaining a computer for their exclusive use. Therefore, libraries will probably have to design operating systems to fit the capabilities of existing computer equipment of the parent organization. The characteristics of the available equipment must be known, particularly in the following:

1. Means of input (punched cards, paper tape, telecommunication).

2. Means of storage (magnetic tape, disc, bulk core, core memory).

3. Storage capacity.

4. Means of output (printer, punched cards, paper tape, console).

5. Relative speed of machine components.

6. Computer time available for library operations.

Developing the Total System Design

The total systems design should show:

1. Primary inputs and outputs.

2. Major activities of the system.

3. Interface among the various systems comprising the total system, illustrating clearly the interface between "manual-manual", "computer-computer" and "manual-computer" activities.

Determining Inputs

1. Determine the input data required to satisfy the system, keeping in mind the arithmetical, logical and speed capabilities of the computer.

2. Evaluate inputs of the present system and determine what additional inputs are required, and/or, what inputs are not required.

Developing Input Media

1. Evaluate existing forms and design new ones as required to capture needed data.

2. Determine, within the characteristics of available computer equipment, the machine-readable media best adapted to the system's requirements. (Punched cards, paper tape, etc.)

3. Evaluate and select equipment to be used in the library to generate machine-readable input records. (Keypunch, tape typewriter, optical scanner, on-line terminal, etc.)

Determining Outputs

1. Define the reports necessary to satisfy the reporting system.

2. Determine the frequency of these reports.

3. Identify the data needed in each report.

4. Identify the source of data.

5. Identify the bibliographic, fiscal, and inventory records to be maintained in the system.

6. Identify the data needed in the accurate up-dating of each record, and, its source.

Develop Output and Storage Media

1. Determine the form best suited for reports, e.g., punched card, paper tape, print, etc., within the limitations of available equipment.

2. Design each report to best satisfy the objectives of the system.

3. Determine the type of storage media required for each record for efficient processing (sequential or random processing) within the capabilities of available equipment, i.e., magnetic tape, punched cards, disc.

4. Evaluate and select the equipment to be used in the library to process and store computer output.

Define the Functions

1. Identify functions required to successfully meet the system's requirements.

2. Identify those functions to be performed under programmed control and those under manual control.

3. Describe in detail the procedures of each function.

Define the Decisions

1. Identify the decisions necessary to accomplish the objectives of the system.

2. Identify decisions which may be delegated to the computer under programmed control; if a decision involves personal intervention, identify the responsible person.

3. Identify the criteria upon which each decision is based.

4. Identify the source-records and reports from which the data is obtained for making each decision.

Define Resulting Actions

1. Identify the actions to be taken as a result of each decision.

2. Identify the functions and/or further decisions resulting from each action.

Prepare the Flow Chart

At this point the study staff prepares a flow chart of the new system in sufficient detail: (a) to permit the programming of the computer-based parts of the system, and (b) to permit preparation of detailed instructions for the manual parts of the system. As discussed in Section VI, Evaluation of the Current Operating System, the flow chart can be used as a simulator to test the new system under various operating conditions. The system must be evaluated with respect to how well it satisfies the goals defined for the system.

Evaluate and Modify the Newly Designed System

Systems should be evaluated in terms of how well they satisfy the following objectives:

1. Improving service to the library user.

2. Improving the public image of the library.

3. Improving the quality, timeliness, and form of data supplied to each management level.

4. Eliminating undesirable duplication of effort within the system as well as other systems within the library.

5. Increasing the efficiency and effectiveness of each level of management.

6. Improving the coordination between systems.

7. Achieving economy of operation by providing one or more of the following:

   a. Increase in clerical and professional productivity.

   b. Reduction in operating cost.

   c. Elimination of unnecessary functions.

   d. Utilization of personnel and equipment to the maximum level.

Final Steps

(Costing, Reporting, Writing Manuals, Debugging)

1. Estimate the cost of installing the new system.

2. Compare cost of the old system with that of the new.

3. Determine the staffing requirements of the new system.

4. Prepare a summary report for the director of the library, outlining the salient features of the new system.

5. Prepare detailed procedural manual for each major activity in the system.

6. Prepare detailed procedural manual and time schedule for conversion to and installation of the new system.

7. Program and "debug" the computer systems involved.

APPENDIX

FLOW CHARTING EXAMPLES

Example 1: Processing of an invoice is an operation of the accounting and reporting sub-system of the acquisition system.

Requirements of the operation:

a. To provide the Comptroller's Office with the verified invoice.

b. Provide the actual cost of the book(s) for the accounting and reporting sub-system.

Input to the operation:

a. Invoice from publisher or vendor

Output of the operation:

a. Processed invoice

Functions in the operation:

a. Check invoice

b. Code invoice

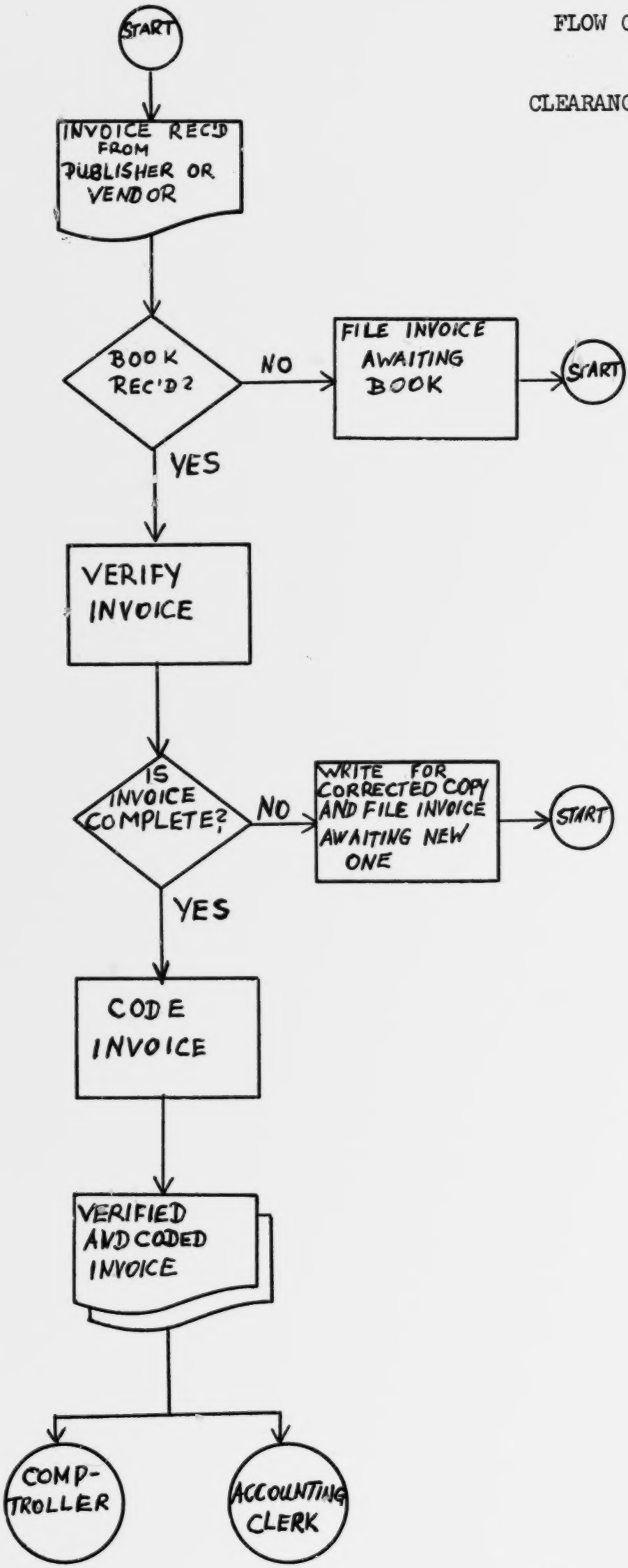
Decisions in the operation:

a. Have books been received?

b. Is the invoice complete?

FLOW CHART EXAMPLE 1

CLEARANCE OF AN INVOICE



Example 2: Processing "added volumes" - a component of the Cataloging System.

Requirements of the operation:

a. Book to be cataloged as a separate or with set.

b. Update catalog records.

c. Process book for shelving.

Inputs to the operation:

a. Book received from Acquisitions System. (Primary input)

b. Instructions from Acquisitions System. (Instructional input)

Output of the operation:

a. Completely processed book ready for shelving.

Functions of the operation:

a. Verify call number.

b. Accession numbering and property stamping.

c. Label book.

d. Insert book pockets.

e. Update catalog records.

f. Revise clerical work.

Decisions of the operation:

a. Is this book to be cataloged as a separate? If so, forward to Technical Assistant for such handling.

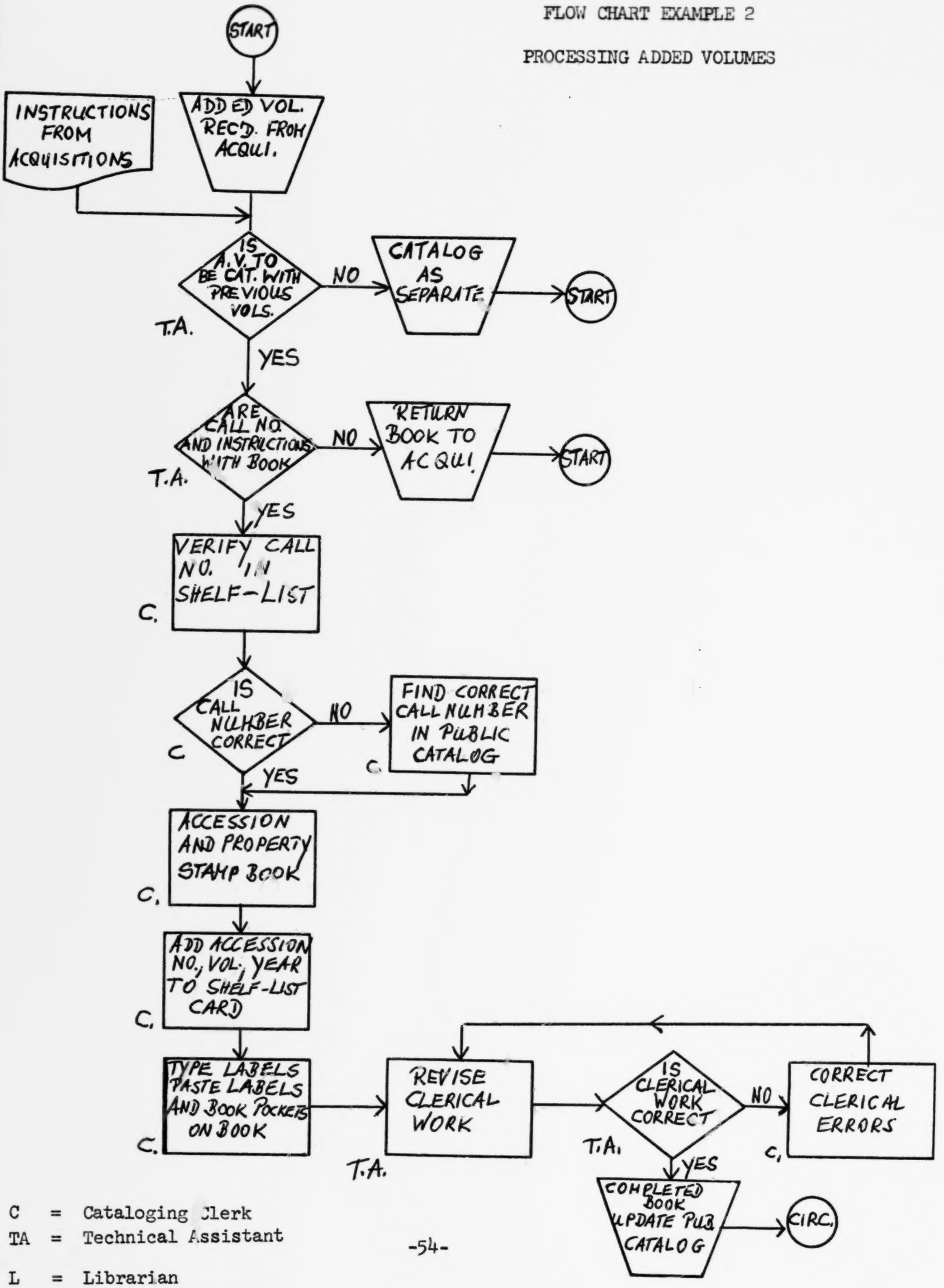
b. Instructions sufficient for processing? If not, return to Acquisitions System.

c. Call number correct? If not, obtain correct number.

d. All clerical operations have been performed correctly? If not, return to clerk for corrections.

FLOW CHART EXAMPLE 2

PROCESSING ADDED VOLUMES



C = Cataloging Clerk
TA = Technical Assistant

L = Librarian